LONWORKS™ Installation Overview

August 1991 **LONWORKS Engineering Bulletin**

Introduction

Local operating network (LON®) technology offers a powerful means for implementing a wide variety of distributed systems that perform sensing, monitoring, and control. This engineering bulletin explains the various ways to install a LON network, i.e., assemble individual intelligent nodes into an interoperating network.

What is LONWORKS Installation?

When conventional electrical devices are installed, the wiring between the devices fulfills a dual purpose. It physically interconnect the devices and propagates control signals among them. Once attached to the wire, the behavior and interaction among the devices is fully defined. It is also unalterable unless the wiring is modified.

With LONWORKS technology, devices are connected to their physical medium (e.g., twisted-pair wire) in much the same way as with conventional products. However, the physical attachment only interconnects the devices; it does not specify how the devices interoperate. Giving nodes a unique network personality and specifying how they communicate and share information are additional key steps in LONWORKS installation.

In a LONWORKS system, hardware design, software design and network design are all independent tasks. This means that a node's function can be specified and programmed without concern about the specifics of the network or networks in which it will be used. This has several major benefits.

First, it reduces development effort and cost. Nodes can become generic building blocks that can be used in multiple applications to accomplish different tasks. For example, a generic motion sensor node could be used in a twisted pair network monitoring parts on an assembly line. It may also be used as a room occupancy sensor in an RF network, without any change to the application code. The tasks the node performs in any given situation are determined by the way in which it has been connected to other nodes in the network.

Second, the separation of the various design tasks enables systems of unprecedented flexibility and interoperability. Because network parameters are independent of node application code and physical network attachment, new nodes can be added and connections between nodes can be changed dynamically to logically 'rewire' a network and redefine network behavior without the cost and delay associated with running new wires. Additionally, once installed, the nodes in one LONWORKS-based network can become components in any other LONWORKS-based network to provide increased function without increased cost. For example, the motion detector nodes used in a lighting system may be connected to an alarm system programmed

to sound an alarm (or transmit a message to a law enforcement agency) whenever motion is detected in certain rooms during certain hours of the day.

LONWORKS technology provides a very flexible environment, with many ways to install nodes and to tune many network parameters based on application needs. However, it is not necessary to use all the power of LONWORKS technology to enjoy the majority of its benefits. The task of designing LONWORKS networks becomes one of picking and choosing the options that are of value in a given application and presenting them in a way that is convenient to the end user or installer.

The ABC's of Installation (Addressing, Binding, Configuring)

Customizing a generic node to give it a unique network personality involves specifying and loading certain pieces of information. The tasks for managing this information are address assignment, binding, and configuration. How and when the information is provided depends upon the installation scenario and will be discussed in further detail in a later section. In each scenario, however, Echelon provides tools to easily accomplish the required tasks.

Address Assignment

LONWORKS nodes communicate with each other by sending messages. Much like a postal address identifies a house to the mail carrier, a node's network address identifies it to LONWORKS messages. The process of address assignment is nothing more than pairing a *physical* node with a *logical* network address.

This association is made using the unique ID of the NEURON CHIP in the node. Each NEURON CHIP is given a unique ID at manufacture time which, like a serial number, differentiates it from all the other NEURON CHIPs in the world. There are several methods, which will be discussed later, for extracting a NEURON CHIP's unique ID and pairing it with a network address.

There are many advantages to using logical network addresses, rather than physical serial numbers, to communicate with a node. For example, when replacing a damaged node, a new node is given the same network address as the old, damaged node. The exchange of physical devices is transparent to the rest of the network since the network address is unchanged; none of the other nodes need to be informed of the repair. Logical network addresses also increase the efficiency and performance of the message delivery system.

Binding

As has been mentioned, physically attaching LONWORKS nodes to the medium only interconnects devices. Address assignment connects nodes logically. However, neither specifies how nodes communicate and share information. Binding accomplishes this task. It enables LONWORKS systems to be installed and modified efficiently and economically.

In a LONWORKS network, nodes exchange control information via objects called Network Variables (NVs). The types, functions, and number of NVs in each node are determined by the application code within the node. Binding the NVs of two nodes together requires sharing network address information that results in information describing the logical connection between them as well as the physical addresses of those nodes being stored within the EEPROM of the NEURON CHIP. To send a NV on one node to a NV on another node, you only need to know the network address of the destination NV. Changing or adding destinations only requires changing or adding destination network addresses; the node application code and physical wires attaching nodes do not need to be changed.

Configuration

For most applications, address assignment and binding are enough to install the network. LONWORKS technology does, however, provide the flexibility to customize and tune network behavior and response characteristics if an application requires. For example, network performance can be fine-tuned by adjusting communication parameters, such as timeouts and node priorities. Nodes can be further customized by setting installation-specific information such as location, temperature set points, etc., or by activating other features of LONWORKS technology such as authentication.

Installation Scenarios

Where, when and who sets the address, binding and configuration information of the nodes in a network varies by application. Although LONWORKS technology provides many options for customization, it is not required or expected that each network use all the options. The following scenarios represent a wide variety of customer situations categorized by where and by whom the ABCs of installation are done.

Manufacture-time Installation

For many networks, addressing, binding and configuration information can be set at the time of manufacture. This is appropriate for networks that do not require site-specific customization. For example, an embedded control system in a machine such as a photocopier might contain a number of nodes forming a single twisted-pair network. The copier operates the same no matter where it is. Although the accessories any given copier is equipped with (e.g., collators, staplers) might vary, they always interoperate the same way when attached to the network.

Another example is a 'blister pack' of devices sold as a single unit. Blister packs are a collection of prepackaged nodes forming a system preconfigured to work as a unit. For example, a LONWORKS-based lighting system might include ambient light detectors, motion detectors, multiple switches and multiple lights all preconfigured to communicate with each other over a powerline network. To 'install' the

products, they only need to be physically attached to the powerline. No additional customization is required to define the function of the system.

In these types of systems, the LONBUILDER™ Developer's Workbench can be used to set the addressing, binding and configuration information for the network. For example, when defining the photocopier network, a copier with every possible attachment would be built using the LONBUILDER development environment. The LONBUILDER system would be used to generate all the installation information required for each node in the system. Then, as part of the manufacturing process, when each node is given its application code, it would also be given its network personality. Nodes with the same function would have the same logical network addressing, binding and configuration information. This means that all parts with the same function are totally interchangeable.

Partial Field Customization

Manufacture-time installation is a simple-to-implement, low-cost solution for situations where the system is self-contained. In cases where the system is not self-contained, but each node has a single function, LONWORKS technology provides the tools to do binding and configuration at manufacture time and the address assignment quickly and easily in the field.

For example, the lighting system described above might be installed in every room of an office building. The function of each network is the same (i.e., the binding and configuration information is the same), but a unique network address is needed for each system to prevent the motion detector in one room from turning on the lights in another room. The tools provided with the LONBUILDER Developer's Workbench are all that is necessary to support this scenario. The only additions to the nodes described above are a few lines of NEURON C code and some switches.

The NEURON C language provides functions for a node to set its own network address information. To make use of these functions, each node must be built with some sort of input hardware for the installer to set the address. The hardware could be as simple as a pair of thumb-wheel switches. When the node is reset, the application code uses the I/O input functions of NEURON C to read the switch settings and then calls the network address modification functions of NEURON C to set the network address information. The remaining application code in the node would be unchanged.

To manufacture the system, the process is the same as in the manufacture-time installation scenario discussed above. A network with every possible attachment would be built in the LONBUILDER development environment and the LONBUILDER system would be used at development time to generate the installation information required for each node in the system. Then, as part of the manufacturing process, when each node is given its application code, it would also be given its network personality. The difference is that in the field the installer would need to set all the nodes in the same system (i.e., all the lighting system nodes in a given room) to the

same network address. The only tool required to do this would be a finger or a screw driver; the bulk of the installation has already been done at the factory.

Site-specific Installation

A third type of network is one where the content and function of the network is very site specific, the behavior of the network is changed repeatedly over time, or there are complex interactions between products from multiple vendors. This type of environment might be found in factory automation and high-end building automation systems. These systems often have strict application-level performance and cost constraints, and are often designed in response to a set of plans and specifications.

In this type of application, all three installation tasks (address assignment, binding, and configuration) need to be done in the field. To make this process easier, the LONTALK™ protocol includes a special class of messages called network management messages. These messages perform many tasks, including address assignment and network variable binding. Echelon offers tools that use the services provided by these messages to help simplify the process of designing and developing an appropriate installation tool for the given application.

Address Assignment

The first task to be accomplished is address assignment. There are three ways to pair a physical node with a logical network address. The first is to use the service pin provided on each NEURON CHIP. Grounding this pin (for example, through the use of a simple push button on the node) causes the NEURON CHIP to transmit a network management message containing its unique ID. The installation tool can look for these messages and pair them with the nodes being installed.

For cases where it is impractical to physically access a node to press a service push-button, such as when the node is installed behind a wall or in a false ceiling, the installation tool node can send out a 'Query ID' network management message asking all unconfigured nodes to identify themselves. If more than one node responds, the installation tool can use the `wink` network management message to differentiate among the nodes. Based on the application code within the node, when a node receives a `wink` message, it responds in a way that can be easily detected by the person doing installation. For example, lights can blink, alarms can ring, motors can turn, and so on. The person doing the installation can then associate physical application nodes responding to a particular `wink` message as the one currently being installed.

The final method to pair physical nodes with logical network addresses is manually. The installer can enter the unique ID of each device. Alternatively, each node could be manufactured with a bar code that contains the unique ID of the NEURON CHIP on the node. As each node is installed, the bar code could be peeled off and placed on a set of building plans next to another bar code defining the location. Manually

entering the data could be as easy as running a bar code reader over the coded location on the building plan (representing the logical network address) followed by running the reader over the bar code containing the unique ID of the node at that location.

Any given installation tool can choose to use any or all of these methods of address assignment in any combination. The choice should be based on how much information is provided in the tool versus how much is left to the installer. That decision is made by the product manufacturer and is based on a number of factors including skill level of the installation personnel.

Binding

Several features built into every NEURON CHIP help make binding easier. Each LONWORKS node contains a *Program ID* that is set at manufacture time. This ID contains information such as device type, manufacturer, and model number. This information can be used to provide automated binding. For example, in a factory control system, the content of the network may be site-specific (e.g., number of sensors and stations present), but the communication between nodes of a given type may always be the same (a proximity sensor always binds to the same network variable on a drill press). In this case, an installation tool can be built to listen for a series of service pin messages and bind the nodes in a standard way based on the type of node. If desired, the tool could even have the option of overriding default settings to provide even greater flexibility.

Another LONWORKS feature that makes binding easier is Standard Network Variable Types (SNVTs). A developer does not have to use SNVTs; network variables of any arbitrary type may be defined. However, if SNVTs are used, the developer of a LONWORKS node has the option of enabling nodes to identify and document their network variable inputs and outputs *over the network*. This is accomplished by storing within the node two key pieces of information about each of the node's network variables: the SNVT ID number, and a text string. Using standard network management commands, an installation tool can extract the SNVT information (ID# and text string) from any other node. This information can then be displayed to help the installer determine which network variables on various nodes should be bound together.

Configuration

Once a node has been given an address, any configuration information required can be sent to it using network management messages. This could be an automatic process based on the standard program ID, a manual process requiring input from the person doing installation, or a combination of the two. The choice depends on the flexibility required of the application.

Building Installation Tools

Special-purpose installation tools like the ones described above are built using the LONMANAGER™ Application Programming Interface (API) for DOS. The API is a comprehensive set of software libraries for creating LONWORKS network management applications running on MS-DOS or PC-DOS computers. The development libraries provide designers with simplified access to LONWORKS network functions. Not only are routines included for installing LONWORKS networks (assigning addresses, binding network variables, changing configuration parameters), but routines are also provided to enable the construction of more general purpose network management applications for monitoring and control. Like existing APIs for screen managers, database managers, and LANs, the LONMANAGER API is a tool for programmers; it provides a set of services that frees them to concentrate on their application.

A typical installation tool built using the LONMANAGER API might use the services of other third-party APIs. For example, if more than a simple text interface is desired, a screen manager API could be used to provide anything from text windows with fill-in forms to a full graphical interface with windows, buttons and pull-down menus. The most important part of the application is that which is provided by the application programmer. The API can be used to create a general-purpose and flexible installation tool requiring frequent interaction with the installer, or it can be used to build an application-specific tool requiring almost no interaction with the installer. The choice between flexibility, cost, ease-of-use, and level of automation is left to the developer; the developer knows the skill level of the installer and the requirements of the application.

Summary

Installation in a LONWORKS system is the process of setting the address, binding, and configuration information that turns a generic application node into an integrated part of an intelligent network. Where the various pieces of information are set and how much skill is required on the part of the installer varies greatly depending on the needs of the application; for many applications, the majority of the installation tasks can be completed in the factory.

By separating hardware, software, and network design into independent tasks, LONWORKS technology produces the potential for systems of unprecedented flexibility and interoperability. It also provides the means to lower the development time and cost through the use of existing LONWORKS nodes in new applications.

Finally, it offers the room to grow. A network that is installed at the time of manufacture today can always use a more flexible installation tool based on the LONMANAGER API later when the network becomes larger or when interoperability to other vendors' systems becomes attractive.

Disclaimer

Echelon Corporation assumes no responsibility for any errors contained herein.
No part of this document may be reproduced, translated, or transmitted in any form without permission from Echelon.

Echelon Corporation
4015 Miranda Avenue
Palo Alto, CA 94304
Telephone (415) 855-7400
Fax (415) 856-6153

Echelon Europe Ltd
105 Heath Street
London NW3 6SS
England
Telephone (071) 431-1600
Fax (071) 794-0532
International Telephone + 44 71 431-1600
International Fax + 44 71 794-0532

Echelon Japan K.K.
AIOS Gotanda Building #808
10-7, Higashi-Gotanda 1-chome,
Shinagawa-ku, Tokyo 141, Japan
Telephone (03) 3440-8638
Fax (03) 3440-8639

Part Number 005-0006-01